DATA TRANSLATION

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DT9816
User's Manual

Sixth Edition
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Radio and Television Interference

This equipment has been tested and found to comply with CISPR EN55022 Class A, and EN50082-1 (CE) requirements and also with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Changes or modifications to this equipment not expressly approved by Data Translation could void your authority to operate the equipment under Part 15 of the FCC Rules.

Note: This product was verified to meet FCC requirements under test conditions that included use of shielded cables and connectors between system components. It is important that you use shielded cables and connectors to reduce the possibility of causing interference to radio, television, and other electronic devices.

Canadian Department of Communications Statement

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la class A prescrites dans le Règlement sur le brouillage radioélectrique édicté par le Ministère des Communications du Canada.

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About this Manual

The first part of this manual describes how to install and set up your DT9816 module and software, and verify that your module is working properly.

The second part of this manual describes the features of the DT9816 module and device driver, and how to program the DT9816 module using the DT-Open Layers for .NET Class Library™ software. Troubleshooting information is also provided.

Note: For more information on the class library, refer to the *DT-Open Layers for .NET Class Library User's Manual*. If you are using the DataAcq SDK or a software application to program your device, refer to the documentation for that software for more information.

Unless otherwise specified, all references to the DT9816 module refer to both the DT9816 and DT9816-A model numbers.

Intended Audience

This document is intended for engineers, scientists, technicians, or others responsible for using and / or programming the DT9816 module for analog input, digital I / O, or counter / timer operations in the Microsoft® Windows® 2000, Windows XP, or Windows Vista™ operating system. It is assumed that you have some familiarity with data acquisition principles and that you understand your application.

How this Manual is Organized

This manual is organized as follows:

- Chapter 1, "Overview," describes the major features of the DT9816 module, as well as the supported software and accessories for the module.
- Chapter 2, "Preparing to Use a Module," describes how to unpack the module, check the system requirements, and install the software.
- Chapter 3, "Setting Up and Installing the Module," describes how to install the module and how to configure the device driver.
- Chapter 4, "Wiring Signals to the Module," describes how to wire signals to the module.
- Chapter 5, "Verifying the Operation of a Module," describes how to verify the operation of the module with the Quick DataAcq application.
- Chapter 6, "Principles of Operation," describes all of the features of the DT9816 module and how to use them in your application.
- Chapter 7, "Supported Device Driver Capabilities," lists the supported subsystems and the associated capabilities accessible using the device driver for the DT9816 module.
- Chapter 8, "Troubleshooting," provides information that you can use to resolve problems with a DT9816 module, should they occur.
- Appendix A, "Specifications," lists the specifications of the DT9816 module.
- Appendix B, "Screw Terminal Assignments," shows the screw terminal assignments of the DT9816 module.
- An index completes this manual.

Conventions Used in this Manual

The following conventions are used in this manual:

- Notes provide useful information or information that requires special emphasis, cautions provide information to help you avoid losing data or damaging your equipment, and warnings provide information to help you avoid catastrophic damage to yourself or your equipment.
- Items that you select or type are shown in **bold**.

Related Information

Refer to the following documents for more information on using the DT9816 module:

- *Benefits of the Universal Serial Bus for Data Acquisition*. This white paper describes why USB is an attractive alternative for data acquisition. It is available on the Data Translation web site (www.datatranslation.com).
- *Measure Foundry Manual* (UM-19298) and online help. These documents describe how to use DT Measure Foundry™ to build drag-and-drop test and measurement applications for Data Translation® data acquisition devices.
- *DT-Open Layers for .NET User's Manual* (UM-22161). For programmers who are developing their own application programs using Visual C# or Visual Basic .NET, this manual describes how to use the DT-Open Layers for .NET Class Library to access the capabilities or Data Translation data acquisition devices.

- *DataAcq SDK User's Manual* (UM-18326). For programmers who are developing their own application programs using the Microsoft C compiler, this manual describes how to use the DT-Open Layers DataAcq SDK™ to access the capabilities of Data Translation data acquisition devices.
- *DTx-EZ Getting Started Manual* (UM-15428). This manual describes how to use the ActiveX controls provided in DTx-EZ™ to access the capabilities of Data Translation data acquisition devices in Microsoft Visual Basic® or Visual C++®.
- *DAQ Adaptor for MATLAB* (UM-22024). This document describes how to use Data Translation's DAQ Adaptor to provide an interface between the MATLAB Data Acquisition subsystem from The MathWorks and Data Translation's DT-Open Layers architecture.
- *LV-Link Online Help*. This help file describes how to use LV-Link™ with the LabVIEW™ graphical programming language to access the capabilities of Data Translation data acquisition devices.
- Microsoft Windows 2000, Windows XP, or Windows Vista documentation.
- USB web site (http://www.usb.org).

Where To Get Help

Should you run into problems installing or using a DT9816 module, the Data Translation Technical Support Department is available to provide technical assistance. Refer to Chapter 8 for more information. If you are outside the United States or Canada, call your local distributor, whose number is listed on Data Translation's web site (www.datatranslation.com).

1

Overview

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Key Hardware Features

The DT9816 module is part of the ECONseries of economy, multifunction mini-instruments. Table 1 lists the key features of the module.

Table 1: Key Features of the DT9816 Module

Module	Analog Inputs	Analog Input Resolution	I/O Range	Analog Input Sample Rate	Digital I/O	C/T
DT9816	6 SE	16-bit	±10 V or ± 5 V	50 kS/s per channel	8 in/ 8 out	1
DT9816-A	6 SE	16-bit	±10 V or ± 5 V	150 kS/s per channel[a]	8 in/ 8 out	1

a. Actual maximum is 153.846 kHz.

The DT9816 is a low-power device (less than 100 mA draw).

Simultaneous Analog Inputs

The DT9816 module features six independent, 16-bit, successive-approximation A / D converters with track-and-hold circuitry. Each converter uses a common clock and trigger for simultaneous sampling of all six analog input signals at up to 50 kHz per channel (DT9816) or up to 150 kHz per channel (DT9816-A). All channels in the channel list are read simultaneously on a single pulse of the internal clock.

The DT9816 module provides gains of 1 and 2, for effective full-scale input signal ranges of ±10 V and ±5 V.

Counter/Timer Channel

The DT9816 module supports one 16-bit counter / timer channel. This counter / timer allows you to perform event counting, frequency measurement, and continuous pulse output (rate generation) operations.

Clocks and Triggers

The DT9816 modules supports an internal and external trigger, and an internal and external clock.

Use the internal trigger to start an analog input operation based on a software command, or use the external trigger to start an analog input operation based on an external event.

Use the external clock signal to pace an analog input operation at a rate not available with the internal clock or when you want to pace at uneven intervals.

Supported Software

The following software is available for use with the DT9816 module, and is provided on the OMNI CD:

- **Device Driver** – The DT9816 Device Driver allows you to use a DT9816 module with any of the supported software packages or utilities. Refer to Chapter 2 for more information on loading the device driver.
- **Quick DataAcq application** – The Quick DataAcq application provides a quick way to get up and running using a DT9816 module. Using this application, you can verify key features of the modules, display data on the screen, and save data to disk. Refer to Chapter 5 for more information on using the Quick DataAcq application.

- **The quickDAQ application –** An evaluation version of this .NET application is included on the Data Acquisition OMNI CD. quickDAQ lets you acquire analog data from all devices supported by DT-Open Layers for .NET software at high speed, plot it during acquisition, analyze it, and / or save it to disk for later analysis.
- **Measure Foundry** – An evaluation version of this software is included or provided via a link on the OMNI CD. DT Measure Foundry is drag-and-drop test and measurement application builder designed to give you top performance with ease-of-use development. Order the full development version of this software package to develop your own application using real hardware.
- **DT-Open Layers for .NET Class Library** – Use this class library if you want to use Visual C# or Visual Basic for .NET to develop your own application software for a DT9816 module using Visual Studio 2003 or Visual Studio 2005; the class library complies with the DT-Open Layers standard.
- **DataAcq SDK** – Use the Data Acq SDK if you want to use Visual Studio 6.0 and Microsoft C or C++ to develop your own application software for a DT9816 module using Windows 2000, Windows XP, or Windows Vista; the DataAcq SDK complies with the DT-Open Layers standard.
- **DTx-EZ** – Use this optional software package if you want to use ActiveX controls to access the capabilities of the DT9816 module using Microsoft Visual Basic or Visual C++; DTx-EZ complies with the DT-Open Layers standard.
- **DAQ Adaptor for MATLAB** – Data Translation's DAQ Adaptor provides an interface between the MATLAB Data Acquisition (DAQ) subsystem from The MathWorks and Data Translation's DT-Open Layers architecture.

- **LV-Link** – An evaluation version of LV-Link is provided on the OMNI CD.Use this software package if you want to use the LabVIEW graphical programming language to access the capabilities of the DT9816 module.

Getting Started Procedure

The flow diagram shown in Figure 1 illustrates the steps needed to get started using the DT9816 module. This diagram is repeated in each chapter; the shaded area in the diagram shows you where you are in the getting started procedure.

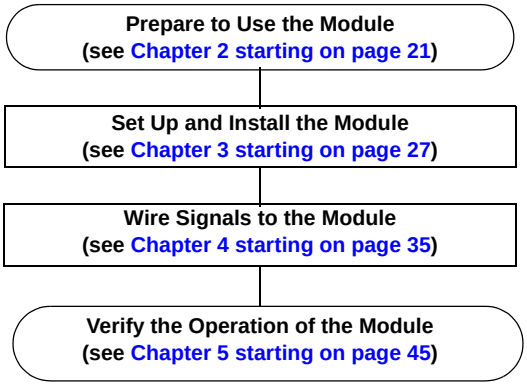
Prepare to Use the Module
(see Chapter 2 starting on page 21)
Set Up and Install the Module
(see Chapter 3 starting on page 27)
Wire Signals to the Module
(see Chapter 4 starting on page 35)
Verify the Operation of the Module
(see Chapter 5 starting on page 45)

Figure 1: Getting Started Flow Diagram

Part 1:
Getting Started

2

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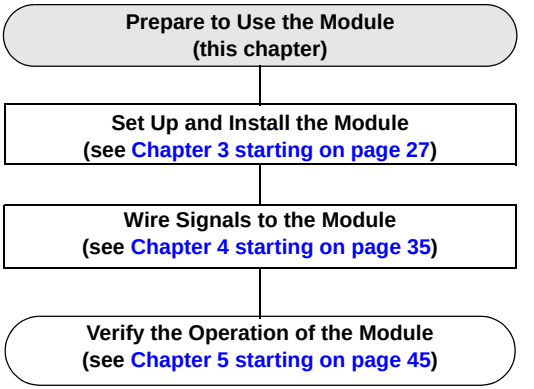
Prepare to Use the Module
(this chapter)
Set Up and Install the Module
(see Chapter 3 starting on page 27)
Wire Signals to the Module
(see Chapter 4 starting on page 35)
Verify the Operation of the Module
(see Chapter 5 starting on page 45)

Unpacking

Open the shipping box and verify that the following items are present:

- DT9816 module
- OMNI CD
- USB cable

If an item is missing or damaged, contact Data Translation. If you are in the United States, call the Customer Service Department at (508) 481-3700. An application engineer will guide you through the appropriate steps for replacing missing or damaged items. If you are located outside the United States, call your local distributor (see Data Translation's web site (www.datatranslation.com) for contact information).

Once you have unpacked your module, check the system requirements, as described in the next section.

Checking the System Requirements

For reliable operation, your DT9816 module requires the following:

- Windows 2000, Windows XP (Professional Edition), or Windows Vista operating system

  For USB Ver. 2.0 support, make sure that you install the appropriate service pack (Service Pack 2 for Windows XP or Service Pack 4 for Windows 2000). In addition, for some systems, you may have to disable standby mode. If you are not sure whether you are using USB Ver. 1.1 or Ver. 2.0, run the Open Layers Control Panel applet, described on page 29.

- Minimum RAM requirements depend on the operating system you are using; consult your operating system documentation for details
- One or more USB ports (Ver. 2.0 or Ver. 1.1). USB Ver. 2.0 is recommended for optimal performance
- One CD-ROM drive

Once you have verified that your system meets the system requirements, install the software, as described in the next section.

Installing the Software

To install the software, perform the following steps:

1. Insert the Data Acquisition OMNI CD into your CD-ROM or DVD drive.
   The installation program should automatically start, and the InstallShield Wizard should appear.
2. If the installation program does not automatically start, double-click **Setup.exe** from the CD.
   The InstallShield Wizard appears.
3. Click **Install Drivers**.
   The installation screen appears.
4. Click **Install now!**
   The InstallShield Wizard appears.
5. If your system already has the Microsoft .NET Framework 1.1 software installed, proceed to step 6. Otherwise, the Framework installation begins and you must do the following:
   a. Click the radio button next to "I agree" to accept the license agreement, and then click **Install**.
   b. After the components have been installed, click **OK** to configure them.
   c. Without removing your Data Acquisition OMNI CD, click **Restart** to restart your system.
      When the system restarts, the Windows Installer dialog box appears, followed by the DT-Open Layers InstallShield Wizard.
6. Click **Next**.
   The license agreement appears.
7. Read the license agreement, click the radio button next to "I accept the terms in the license agreement," and then click **Next**.
   The Destination Folder dialog box appears.
8. Change the default destination folder path, if you wish, by clicking **Change**, and then click **Next**.

9. Click **Install**.
The files are copied to the specified destination folder.

10. Click **Finish** to complete the installation process.

Continue with the instructions in Chapter 3 starting on page 27.

3

Setting Up and Installing the Module

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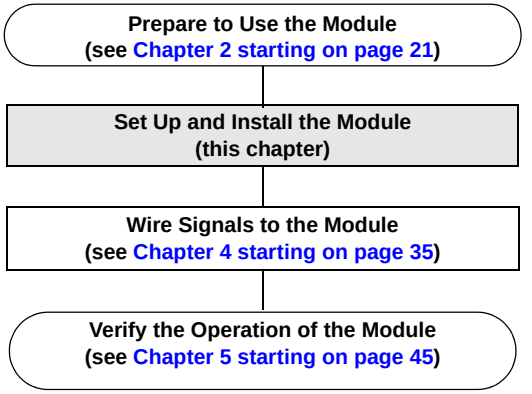
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(see Chapter 2 starting on page 21)
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(this chapter)
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(see Chapter 4 starting on page 35)
Verify the Operation of the Module
(see Chapter 5 starting on page 45)

Note: The DT9816 module is factory-calibrated and requires no further adjustment.

Attaching Modules to the Computer

This section describes how to attach a DT9816 module to the host computer.

Note: Most computers have several USB ports that allow direct connection to USB devices. If your application requires more DT9816 modules than you have USB ports for, you can expand the number of USB devices attached to a single USB port by using expansion hubs. For more information, refer to page 31.

You can unplug a module, and then plug it in again, if you wish, without causing damage. This process is called hot-swapping. Your application may take a few seconds to recognize a module once it is plugged back in.

Connecting Directly to the USB Ports

To connect DT9816 modules directly to the USB ports of your computer, do the following:

1. Attach one end of the USB cable to the USB port on the module.
2. Attach the other end of the USB cable to one of the USB ports on the host computer, as shown in Figure 2.
   The operating system automatically detects the USB module and starts the Found New Hardware wizard.

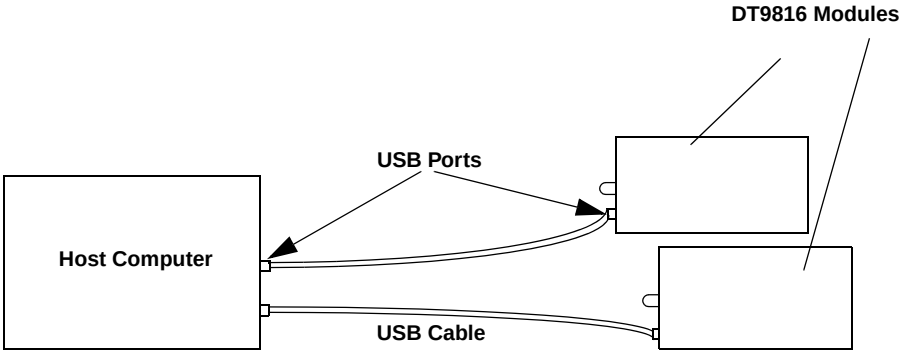

Figure 2: Attaching the Module to the Host Computer

3. For Windows Vista:

a. Click **Locate and install driver software (recommended**).
The popup message "Windows needs your permission to continue" appears.

b. Click **Continue**.
The Windows Security dialog box appears.

c. Click **Install this driver software anyway**.
The LED on the module turns green.

For Windows 2000 and Windows XP:

a. Click **Next** and / or **Finish** as required in the wizard.
Once the firmware is loaded, the wizard restarts to initiate the firmware to accept commands.

b. Click **Next** and / or **Finish** again.
The LED on the module turns green.

4. Repeat these steps to attach another DT9816 module to the host computer, if desired.

Connecting to an Expansion Hub

Expansion hubs are powered by their own external power supply. The practical number of DT9816 modules that you can connect to a single USB port depends on the throughput you want to achieve.

To connect multiple DT9816 modules to an expansion hub, do the following:

1. Attach one end of the USB cable to the module and the other end of the USB cable to an expansion hub.

2. Connect the power supply for the expansion hub to an external power supply.

3. Connect the expansion hub to the USB port on the host computer using another USB cable.
The operating system automatically detects the USB module and starts the Found New Hardware wizard.

4. For Windows Vista:

a. Click **Locate and install driver software (recommended)**.
The popup message "Windows needs your permission to continue" appears.

b. Click **Continue**.
The Windows Security dialog box appears.

c. Click **Install this driver software anyway**.
The LED on the module turns green.

For Windows 2000 and Windows XP:

a. Click **Next** and / or **Finish** as required in the wizard.
Once the firmware is loaded, the wizard restarts to initiate the firmware to accept commands.

b. Click **Next** and / or **Finish** again.
The LED on the module turns green.

5. Repeat these steps until you have attached the number of expansion hubs and modules that you require. Refer to Figure 3.

The operating system automatically detects the USB devices as they are installed.

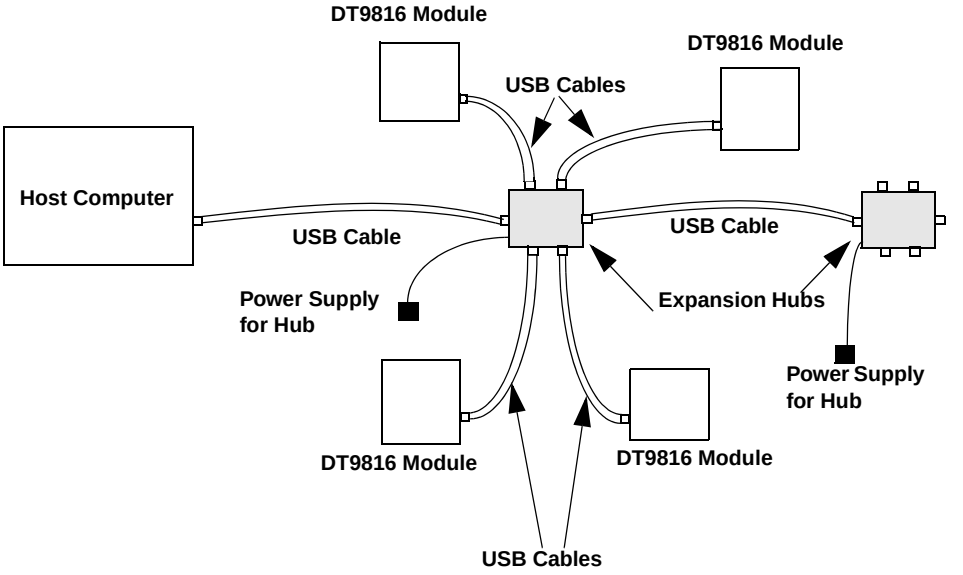

Figure 3: Attaching Multiple DT9816 Modules Using Expansion Hubs

Changing the Name of a Module (Optional)

To change the name of a DT9816 module, configure the device driver as follows:

1. From the Windows Start menu, select **Settings | Control Panel**.
2. From the Control Panel, double-click **Open Layers Control Panel**.
   The Data Acquisition Control Panel dialog box appears.
3. If you want to rename the module, click the DT9816 module that you want to rename, and then click **Edit Name.**
4. Enter a new name for the module, and then click **OK**. The name is used to identify the module in all subsequent applications.
5. When you are finished configuring the module, click **Close**.
6. Repeat steps 3 to 5 for the other modules that you want to configure.
7. Close the Data Acquisition Control Panel dialog box.

Continue with the instructions on wiring in Chapter 4 starting on page 35.

4

Wiring Signals to the Module

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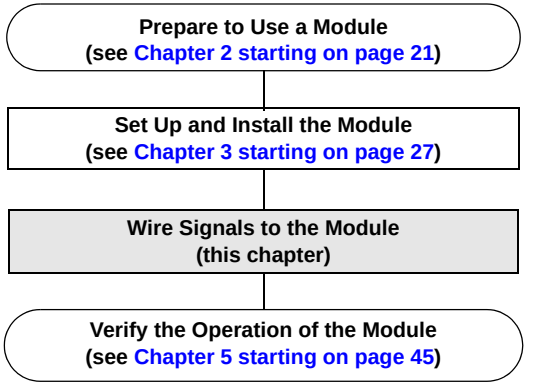
Connecting Counter/Timer Signals 41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(see Chapter 2 starting on page 21)
Set Up and Install the Module
(see Chapter 3 starting on page 27)
Wire Signals to the Module
(this chapter)
Verify the Operation of the Module
(see Chapter 5 starting on page 45)

Preparing to Wire Signals

This section provides recommendations and information about wiring signals to a DT9816 module.

Wiring Recommendations

Keep the following recommendations in mind when wiring signals to a DT9816 module:

- Follow standard ESD procedures when wiring signals to the module.
- Use individually shielded twisted-pair wire (size 16 to 26 AWG) in highly noisy electrical environments.
- Separate power and signal lines by using physically different wiring paths or conduits.
- To avoid noise, do not locate the box and cabling next to sources that produce high electromagnetic fields, such as large electric motors, power lines, solenoids, and electric arcs, unless the signals are enclosed in a mumetal shield.
- Prevent electrostatic discharge to the I/O while the box is operational.
- Connect all unused analog input channels to analog ground.

Wiring Locations

You wire signals to the DT9816 module using the screw terminals on the module. Table 4 lists the screw terminal assignments.

Table 4: DT9816 Screw Terminal Assignments

Terminal	Signal	Terminal	Signal
20	USB +5 V Out	40	Ext Trigger
19	Ground	39	Ext Clock
18	Counter 0 In	38	Ground
17	Counter 0 Out	37	Digital Output 7
16	Counter 0 Gate	36	Digital Output 6
15	Ground	35	Digital Output 5
14	Reserved	34	Digital Output 4
13	Reserved	33	Digital Output 3
12	Reserved	32	Digital Output 2
11	Reserved	31	Digital Output 1
10	2.5 V Reference	30	Digital Output 0
9	Analog Ground	29	Ground
8	Reserved	28	Digital Input 7
7	Reserved	27	Digital Input 6
6	Analog Input CH5	26	Digital Input 5
5	Analog Input CH4	25	Digital Input 4
4	Analog Input CH3	24	Digital Input 3
3	Analog Input CH2	23	Digital Input 2
2	Analog Input CH1	22	Digital Input 1
1	Analog Input CH0	21	Digital Input 0

Connecting Single-Ended Analog Input Signals

The DT9816 supports 6 single-ended analog input channels. Figure 4 shows how to connect single-ended voltage input signals (channels 0 and 1, in this case) to the screw terminals of a DT9816 module.

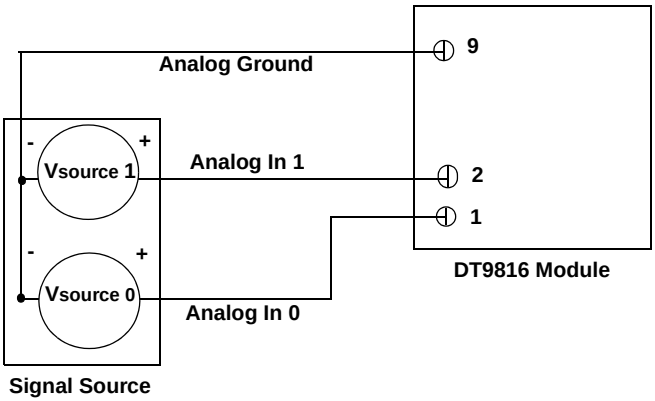

Figure 4: Connecting Single-Ended Inputs

Connecting Digital I/O Signals

Figure 5 shows how to connect digital input signals (lines 0 and 1, in this case) to the screw terminals of a DT9816 module.

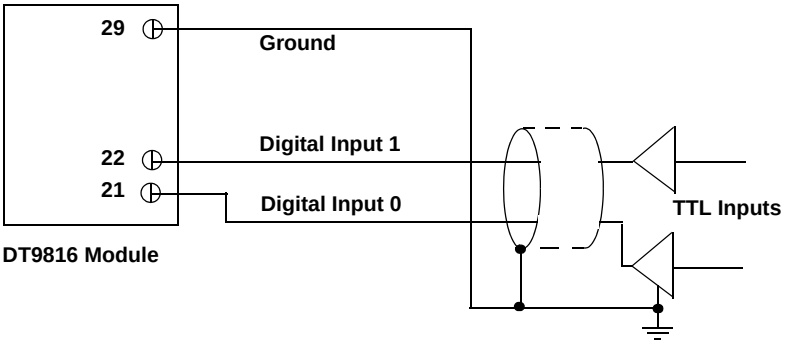

Figure 5: Connecting Digital Inputs

Figure 6 shows how to connect digital output signals (line 0, in this case) to the screw terminals of a DT9816 module.

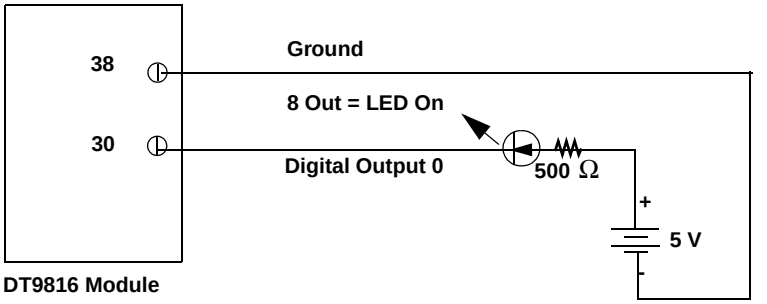

Figure 6: Connecting Digital Outputs

Connecting Counter/Timer Signals

The DT9816 module provides one counter / timer that you can use for the following operations:

- Event counting
- Frequency measurement
- Continuous pulse output (rate generation)

This section describes how to connect counter / timer signals for these operation modes. Refer to Chapter 6 for more information about using the counter / timers.

Connecting Signals for Event Counting

Figure 7 shows how to connect counter / timer signals to the screw terminals on the DT9816 module to perform an event counting operation using an external gate.

In this example, the counter counts the number of rising edges that occur on the Counter 0 In signal when the Counter 0 Gate signal is in the active state (as specified by software). Refer to Chapter 6 for more information.

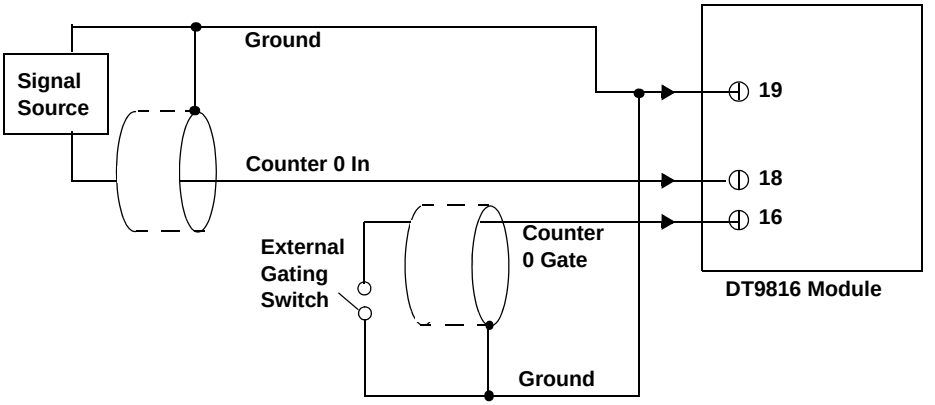

Figure 7: Connecting Counter/Timer Signals for an Event Counting Operation Using an External Gate

Figure 8 shows how to connect counter / timer signals to the screw terminals on the DT9816 module to perform an event counting operation without using a gate (also called a software gate). The counter counts the number of rising edges that occur on the Counter 0 In signal.

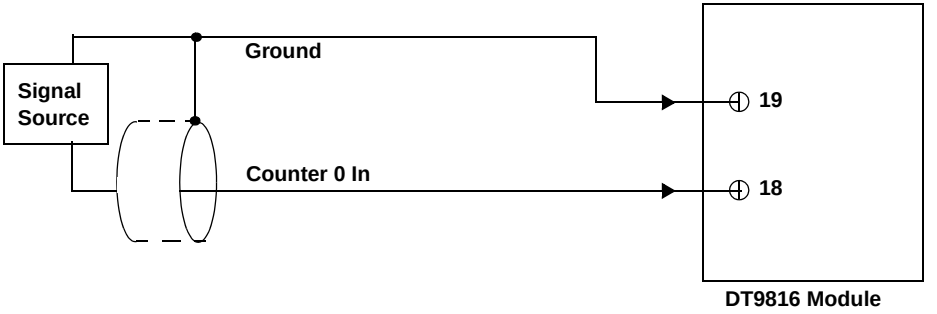

Figure 8: Connecting Counter/Timer Signals for an Event Counting Operation Without Using a Gate

Connecting Signals for Frequency Measurement

One way to measure frequency is to connect a pulse of a known duration to the Counter 0 Gate signal, as shown in Figure 9. In this case, the frequency of the Counter 0 In signal is the number of counts divided by the period of the signal connected to the Counter 0 Gate input.

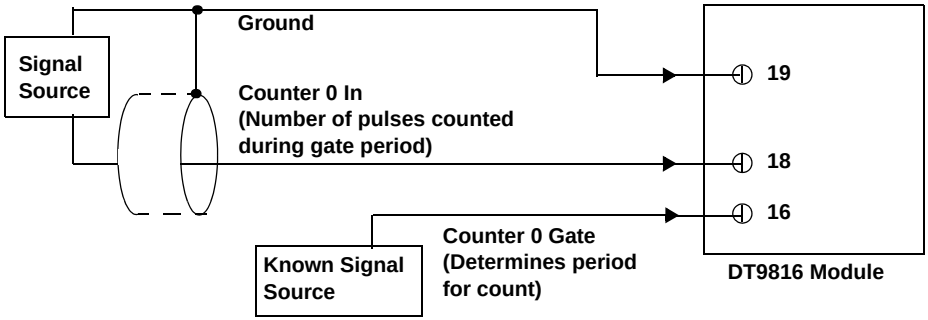

Figure 9: Connecting Counter/Timer Signals for a Frequency Measurement Operation Using an External Pulse

Connecting Signals for Rate Generation

Figure 10 shows how to connect counter / timer signals to the screw terminals of a DT9816 module to perform a rate generation (continuous pulse output) operation.

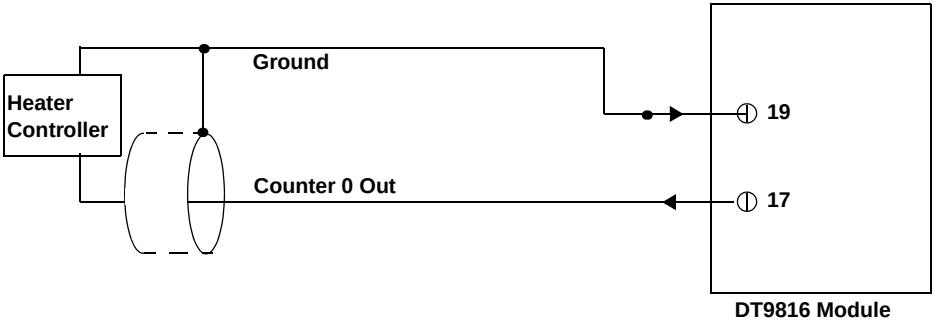

Figure 10: Connecting Counter/Timer Signals for a Rate Generation Operation

5

Verifying the Operation of a Module

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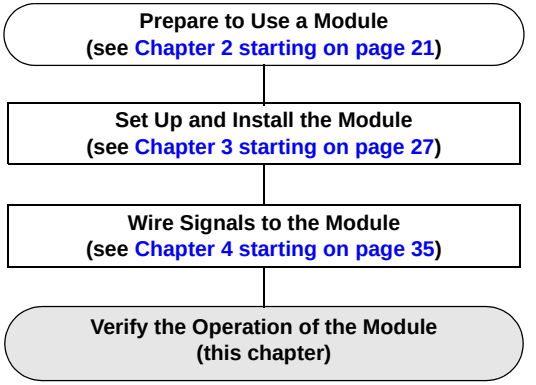
Running the Quick DataAcq Application. 47
Testing Single-Value Analog Input 48
Testing Continuous Analog Input 49
Testing Single-Value Digital Input 50
Testing Single-Value Digital Output 51
Testing Frequency Measurement 52
Testing Pulse Output 53


Prepare to Use a Module
(see Chapter 2 starting on page 21)
Set Up and Install the Module
(see Chapter 3 starting on page 27)
Wire Signals to the Module
(see Chapter 4 starting on page 35)
Verify the Operation of the Module
(this chapter)

Installing the Quick DataAcq Application

The Quick DataAcq application is installed automatically when you install the driver software. See "Installing the Software" on page 24 for more information.

Running the Quick DataAcq Application

To run the Quick DataAcq application, do the following:

1. If you have not already done so, power up your computer and any attached peripherals.
2. Click **Start** from the Task Bar.
3. Browse to **Programs | Data Translation, Inc | DT-Open Layers for Win32 | QuickDataAcq**.
   The main menu appears.

Note: The Quick DataAcq application allows you to verify basic operations on the board; however, it may not support all of the board's features.

For information on each of the features provided, use the online help for the Quick DataAcq application by pressing F1 from any view or selecting the **Help** menu. If the system has trouble finding the help file, navigate to C:\Program Files\Data Translation\Win32\dtdataacq.hlp, where C: is the letter of your hard disk drive.

Testing Single-Value Analog Input

To verify that the module can read a single analog input value, do the following:

1. Connect a voltage source, such as a function generator, to analog input channel 0 (single-ended mode) on the DT9816 module. Refer to page 39 for an example of how to connect a single-ended analog input.
2. In the Quick DataAcq application, choose **Single Analog Input** from the **Acquisition** menu.
3. Select the appropriate DT9816 module from the **Board** list box.
4. In the **Channel** list box, select analog input channel 0.
5. In the **Range** list box, select the range for the channel (±10 V).
6. Select **Single Ended**.
7. Click **Get** to acquire a single value from analog input channel 0. *The application displays the value on the screen in both text and graphical form*.

Testing Continuous Analog Input

To verify that the module can perform a continuous analog input operation, do the following:

1. Connect known voltage sources, such as the outputs of a function generator, to analog input channels 0 and 1 on the DT9816 module (using the single-ended configuration). Refer to page 39 for an example of how to connect a single-ended analog input.
2. In the Quick DataAcq application, choose **Scope** from the **Acquisition** menu.
3. Select the appropriate DT9816 module from the **Board** list box.
4. In the **Sec/Div** list box, select the number of seconds per division (.1 to .00001) for the display.
5. In the **Channel** list box, select analog input channel 1, and then click **Add** to add the channel to the channel list.
   Note that, by default, channel 0 is included in the channel list.
6. Click **Config** from the Toolbar.
7. In the **Config** dialog, select **ChannelType**, and then select **Single Ended**.
8. In the **Config** dialog, select **Range**, and then select **Bipolar**.
9. From the **Scope** view, double-click the input range of the channel to change the input range of the module.
   The display changes to reflect the selected range for all the analog input channels on the module.
10. In the Trigger box, select **Auto** to acquire data continuously from the specified channels or **Manual** to acquire a burst of data from the specified channels.
11. Click **Start** from the Toolbar to start the continuous analog input operation.
    The application displays the values acquired from each channel in a unique color on the oscilloscope view.

12. Click **Stop** from the Toolbar to stop the operation.

Testing Single-Value Digital Input

To verify that the module can read a single digital input value, do the following:

1. Connect a digital input to digital input line 0 of port A on the DT9816 module. Refer to page 40 for an example of how to connect a digital input.
2. In the Quick DataAcq application, choose **Digital Input** from the **Acquisition** menu.
3. Select the appropriate DT9816 module from the **Board** list box.
4. Select digital input port A by clicking **Port A**.
5. Click **Get**.
   The application displays the value of each digital input line in port A on the screen in both text and graphical form.

Testing Single-Value Digital Output

To verify that the module can output a single digital output value, do the following:

1. Connect a digital output to digital output line 0 of port B on the DT9816 module. Refer to page 40 for an example of how to connect a digital output.
2. In the Quick DataAcq application, select **Digital Output** from the **Control** menu.
3. Select the appropriateDT9816 module from the **Board** list box.
4. Select digital output port B by clicking **Port B**.
5. Click the appropriate bits to select the type of signal to write from the digital output lines. If the bit is selected, a high-level signal is output from the digital output line; if the bit is not selected, a low-level signal is output from the digital output line. Optionally, you can enter an output value in the **Hex** text box.
6. Click **Send**.
   The application outputs and displays the value of each digital output line of digital port B on the screen in both text and graphical form.

Testing Frequency Measurement

To verify that the module can perform a frequency measurement operation, do the following:

1. Wire an external clock source to counter / timer 0 on the DT9816 module. Refer to page 43 for an example of how to connect signals to a counter / timer for a frequency measurement operation.

   Note: The Quick DataAcq application works only with counter / timer 0.

2. In the Quick DataAcq application, choose **Frequency Counter** from the **Acquisition** menu.
3. Select the appropriate DT9816 module from the **Board** list box.
4. In the **Count Duration** text box, enter the number of seconds during which events will be counted.
5. Click **Start** to start the frequency measurement operation.
   The operation automatically stops after the number of seconds you specified has elapsed, and the application displays the frequency on the screen.

If you want to stop the frequency measurement operation when it is in progress, click **Stop**.

Testing Pulse Output

To verify that the module can perform a pulse output operation, do the following:

1. Connect a scope to counter / timer 0 on the DT9816 module. Refer to page 44 for an example of how to connect a scope (a pulse output) to counter / timer 0.

   Note: The Quick DataAcq application works only with counter / timer 0.

2. In the Quick DataAcq application, choose **Pulse Generator** from the **Control** menu.
3. Select the appropriate DT9816 module from the **Board** list box.
4. Select **Continuous** to output a continuous pulse stream.
5. Select **High-to-low** to output a falling-edge pulse (the low portion of the total pulse output period is the active portion of the signal).
6. Click **Start** to generate the pulse(s).
   The application displays the results both in text and graphical form.
7. Click **Stop** to stop a continuous pulse output operation.

Part 2:
Using Your Module

6

Principles of Operation

Analog Input Features 59
Digital I/O Features 65
Counter/Timer Features 67

Figure 11 shows a block diagram of the DT9816 module.

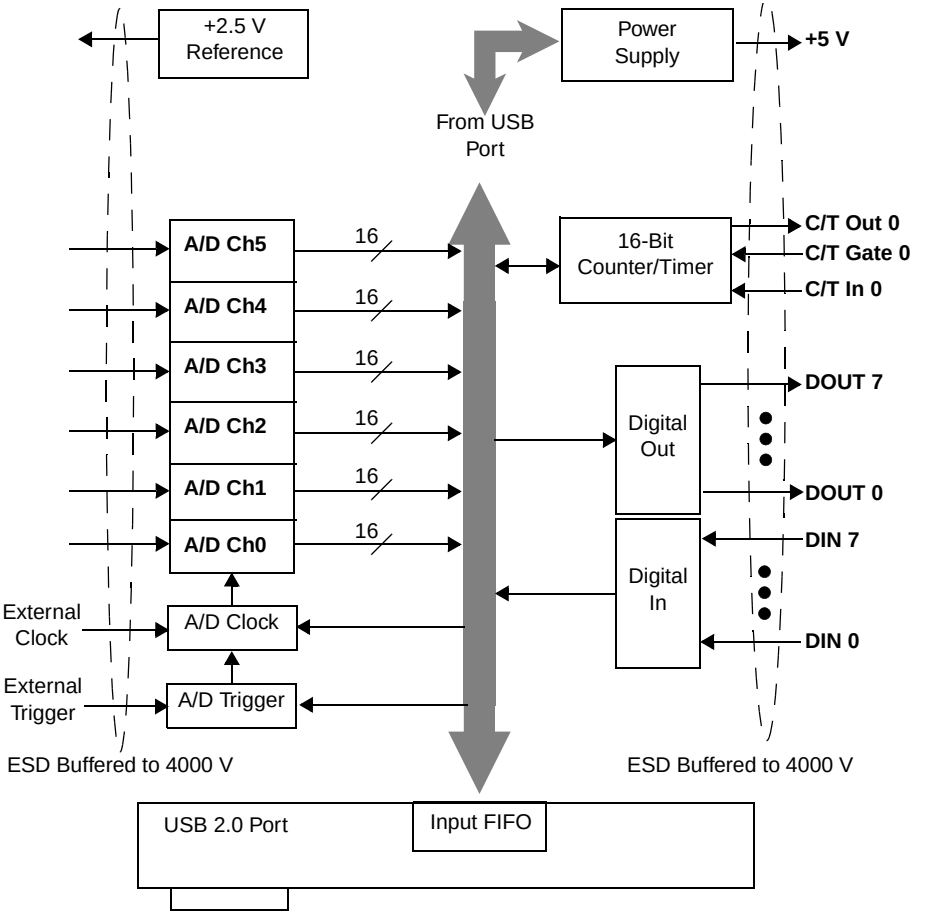


Figure 11: Block Diagram of the DT9816 Module

Analog Input Features

This section describes the following features of analog input (A / D) operations on the DT9816 module:

- Input resolution, described below
- Analog input channels, described below
- Input ranges and gains, described on page 60
- Input sample clock sources, described on page 61
- Analog input conversion modes, described on page 61
- Input triggers, described on page 63
- Data format and transfer, described on page 64
- Error conditions, described on page 64

Input Resolution

The resolution of the A / D subsystem on the DT9816 module is 16-bits. This resolution is fixed; it cannot be programmed in software.

Analog Input Channels

The DT9816 provides six single-ended simultaneous analog input channels. You can acquire data from a single analog input channel or from a group of analog input channels on the module.

Note: To maintain simultaneous operation, all analog input connections must have the same lead lengths.

The following subsections describe how to specify the channels.

Specifying a Single Analog Input Channel

The simplest way to acquire data from a single analog input channel is to specify the channel for a single-value analog input operation using software; refer to page 61 for more information about single-value operations.

You can also specify a single channel using the analog input channel list, described in the next section.

Specifying One or More Analog Input Channels

You can read data from one or more analog input channels using an analog input channel list. Group the channels in the list sequentially (starting either with 0 or with any other analog input channel) in ascending order. You cannot specify the same channel more than once in the list.

Using software, specify the channels you want to sample. You can enter up to 6 entries in the channel list for this module. Refer to page 61 for more information about the supported conversion modes.

Input Ranges and Gains

The DT9816 provides an input range of ±10 V. Use software to specify the range as ±10 V with a gain of 1, or ±10 V with a gain of 2 for an effective input range of ±5 V.

You can specify the gain in a single-value operation, or specify the gain for each entry in the channel list.

Note: This is the range for the entire analog input subsystem, not the range per channel.

Input Sample Clock Sources

You can pace an analog input operation on a DT9816 module using a software clock source. Using software, specify the clock source as internal, then specify the clock frequency at which to pace the operation. The DT9816-A supports an A / D clock frequency of 60 Hz to 150 MHz; the DT9816 supports an A / D clock frequency of 60 Hz to 50 MHz.

According to sampling theory (Nyquist Theorem), specify a frequency that is at least twice as fast as the input's highest frequency component. For example, to accurately sample a 2 kHz signal, specify a sampling frequency of at least 4 kHz. Doing so avoids an error condition called *aliasing*, in which high frequency input components erroneously appear as lower frequencies after sampling.

Analog Input Conversion Modes

The DT9816 supports the following conversion modes:

- Single-value operations
- Continuous scan operations

The following subsections describes the conversion modes in more detail.

Single-Value Operations

Single-value operations are the simplest to use. Using software, you specify the range, gain, and analog input channel. The module acquires the data from the specified channel and returns the data immediately. For a single-value operation, you cannot specify a clock source, trigger source, scan mode, or buffer.

Single-value operations stop automatically when finished; you cannot stop a single-value operation.

Continuous Scan Mode

Use continuous scan mode if you want to accurately control the period between successive simultaneous conversions of all channels in a channel list.

When it receives a software trigger, the module cycles through the channel list, acquiring and converting the data for each entry in the list (this process is defined as the scan). The module then wraps to the start of the channel list and repeats the process continuously until either all the allocated buffers on the subsystem queue are filled or until you stop the operation. Refer to page 64 for more information about buffers.

The conversion rate is determined by the frequency of the internal sample clock; refer to page 61 for more information about the internal sample clock. The sample rate, which is the rate at which a single entry in the channel list is sampled, is the same as the conversion rate due to the simultaneous nature of the module.

To select continuous scan mode, use software to specify the data flow as Continuous.

Figure 12 illustrates continuous scan mode using a channel list with three entries: channel 0, channel 1, and channel 2. In this example, analog input data is acquired simultaneously on all channels on each clock pulse of the input sample clock. Data is acquired continuously.

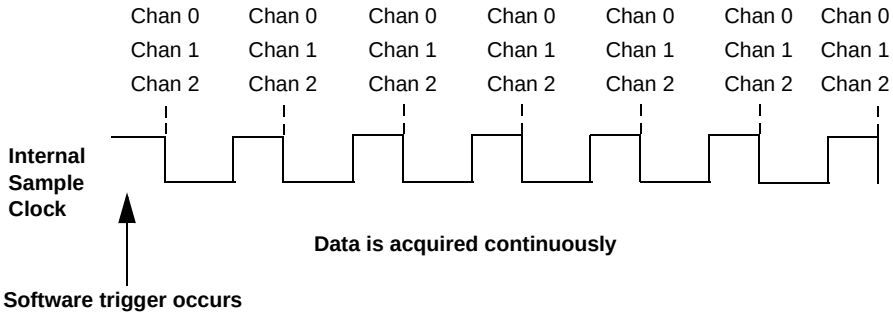


Figure 12: Continuous Scan Mode

Input Triggers

A trigger is an event that occurs based on a specified set of conditions. Acquisition starts when the module detects the initial trigger event and stops when either no more buffers are available or you stop the operation.

The DT9816 module supports the following trigger sources:

- **Software trigger** –A software trigger event occurs when you start the analog input operation (the computer issues a write to the module to begin conversions). Using software, specify the trigger source as a software trigger.
- **External digital (TTL) trigger** – The external trigger is initiated by a falling-edge transition on the A / D external TTL trigger input. Using software, specify the trigger source as an external, negative digital (TTL) trigger.

Data Format and Transfer

DT9816 modules use binary data encoding, where 0000 represents negative full-scale, and FFFFh represents positive full-scale. Use software to specify the data encoding as binary. The ADC outputs FFFFh for above-range signals, and 0000 for below-range signals.

Before you begin acquiring data, you must allocate buffers to hold the data. A buffer done event is returned whenever a buffer is filled. This allows you to move and/or process the data as needed.

We recommend that you allocate a minimum of two buffers for a continuous analog input operation. Data is written to multiple allocated input buffers continuously; when no more empty buffers are available, the operation stops. The data is gap-free.

Error Conditions

An overrun condition is reported if the A/D sample clock rate is too fast. This error is reported if a new A/D sample clock pulse occurs while the ADC is busy performing a conversion from the previous A/D sample clock pulse. The host computer can clear this error. To avoid this error, use a slower sampling rate or increase the buffer size and/or number of buffers.

Digital I/O Features

This section describes the following features of digital I/O operations on the DT9816:

- Digital I/O lines
- Resolution
- Operation modes

Digital I/O Lines

The DT9816 module includes 8 digital input and 8 digital output lines.

Using software, you can specify the digital I/O line that you want to read or write in a single-value digital I/O operation. Refer to page 66 for more information about single-value operations.

A digital line is high if its value is 1; a digital line is low if its value is 0. On power up or reset, a low value (0) is output from each of the digital output lines.

Resolution

The DT9816 provides 16 digital lines that are dedicated, 8 each, to the DIN and DOUT subsystems. By default, these lines are organized as two 8-bit ports. Because these are dedicated lines, you cannot combine the digital ports into one port to change resolution.

Operation Modes

The DT9816 supports single-value digital I/O operations only. For a single-value operation, use software to specify the digital I/O port (the gain is ignored). The DT9816 then reads data from or writes data to the digital lines associated with that port.

Single-value operations stop automatically when finished; you cannot stop a single-value operation.

Counter/Timer Features

This section describes the following features of counter / timer (C / T) operations on the DT9816 module:

- C / T channel, described below
- C / T clock sources, described on page 68
- Gate types, described on page 68
- Pulse types and duty cycles, described on page 69
- C / T operation modes, described on page 69

C/T Channel

The DT9816 module provides one 16-bit counter / timer. The counter accepts a clock input signal and gate input signal and outputs a pulse (pulse output signal), as shown in Figure 13.

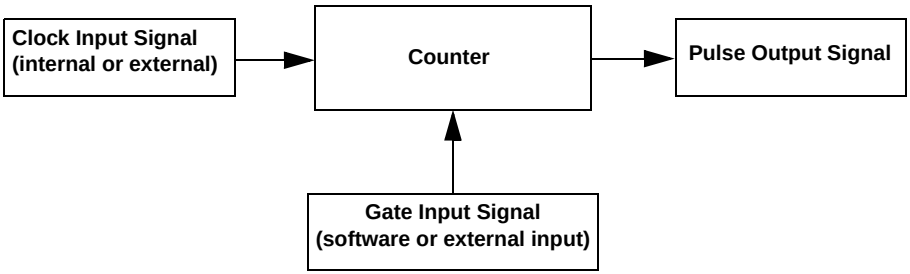


Figure 13: Counter/Timer Channel

C/T Clock Sources

The following clock sources are available for the counter/timer:

- **Internal clock** – Through software, specify the clock source as internal, and specify the frequency at which to pace the counter/timer operation. The frequency of the internal C/T clock can range from 60 Hz to 6 MHz.
- **External clock** – An external clock is useful when you want to pace counter/timer operations at rates not available with the internal clock or if you want to pace at uneven intervals.

  Connect an external clock with a maximum recommended frequency of 6 MHz to the Counter 0 In signal on the DT9816 module. Using software, specify the C/T clock source as external, and specify a clock divider between 2 and 65534 to determine the actual frequency at which to pace the counter/timer operation. For example, if you connect a 6 MHz external C/T clock and use a clock divider of 2, the resulting C/T output frequency is 3 MHz. Counter/timer operations start on the falling edge of the Counter 0 In signal.

Gate Types

The edge or level of the Counter 0 Gate signal determines when a counter/timer operation is enabled. Using software, you can specify one of the following gate types:

- **None** –A software command enables any counter/timer operation immediately after execution.
- **Logic-high level external gate input** –Enables a counter/timer operation when Counter 0 Gate is high, and disables a counter/timer operation when Counter 0 Gate is low. Note that this gate type is used for event counting and rate generation modes; refer to page 69 for more information about these modes.

Pulse Duty Cycles

Counter / timer output signals from the DT9816 module are high-to-low going signals. The low portion of the total pulse output period is the active portion of the counter / timer clock output signal.

The duty cycle (or pulse width) indicates the percentage of the total pulse output period that is active. In rate generation mode, the duty cycle is fixed at 50% for the DT9816 module. Figure 14 illustrates a high-to-low going output pulse with a duty cycle of 50%.

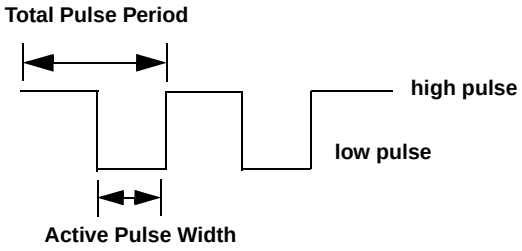


Figure 14: Example of a Pulse Output SIgnal with a 50% Duty Cycle (High-to-Low Going)

Counter/Timer Operation Modes

The DT9816 module supports the following counter / timer operation modes:

- Event counting
- Frequency measurement
- Rate generation

Event Counting

Use event counting mode if you want to count the number of falling edges that occur on Counter 0 In when the gate is active (high-level). Refer to page 68 for information about specifying the active gate type.

You can count a maximum of 65,536 events before the counter rolls over to 0 and starts counting again.

For event counting operations, use software to specify the counter/timer mode as count, the C/T clock source as external, and the active gate type as high-level.

Make sure that the signals are wired appropriately. Refer to Chapter 4 for an example of connecting an event counting application.

Frequency Measurement

Connect a pulse of a known duration to the Counter 0 Gate signal. Specify the active gate in software (high level). When the operation starts, read the number of counts that occurred when the gate was active.

You can determine the frequency of the clock input signal using the following equation:

$$\text{Frequency Measurement} = \frac{\text{Number of Events}}{\text{Measurement Period}}$$

Make sure that the signals are wired appropriately. Refer to Chapter 4 for an example of connecting a frequency measurement application.

Rate Generation

Use rate generation mode to generate a continuous pulse output signal from Counter 0 Out; this mode is sometimes referred to as continuous pulse output or pulse train output.

The pulse output operation is enabled whenever the Counter 0 Gate signal is active (high level or software gate). While the pulse output operation is enabled, the counter outputs a high-to-low going pulse with a pulse width of 50% continuously. As soon as the operation is disabled, rate generation stops.

The frequency of the output is determined by the C/T clock source (either internal or external) and, for an external clock source, the clock divider used. You can generate an output signal from Counter 0 Out with a frequency of 60 Hz to 6 MHz.

To specify rate generation mode, use software to specify the counter/timer mode as rate, the C/T clock source as either internal or external, the clock divider (2 to 65534) if external, and the active gate type (low-level, high-level, or software gate). Refer to page 68 for more information about gate types.

Make sure that the signals are wired appropriately. Refer to Chapter 4 for an example of connecting a rate generation application.

7

Supported Device Driver Capabilities

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The DT9816 Device Driver provides support for the analog input (A / D), digital input (DIN), digital output (DOUT), and counter / timer (C / T) subsystems. For information on how to configure the device driver, refer to Chapter 3.

Table 5: DT9816 Subsystems

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Total Subsystems on Module	1	0	1	1	1	0

The tables in this chapter summarize the features available for use with the DT-Open Layers for .NET Class Library and the DT9816 modules. The DT-Open Layers for .NET Class Library provides properties that return support information for specified subsystem capabilities.

The first row in each table lists the subsystem types. The first column in each table lists all possible subsystem capabilities. A description of each capability is followed by the property used to describe that capability in the DT-Open Layers for .NET Class Library.

Note: Blank fields represent unsupported options.

For more information, refer to the description of these properties in the DT-Open Layers for .NET Class Library online help or *DT-Open Layers for .NET Class Library User's Manual.*

Data Flow and Operation Options

Table 6: DT9816 Data Flow and Operation Options

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Single-Value Operation Support **SupportsSingleValue**	Yes		Yes	Yes		
Simultaneous Single-Value Output Operations **SupportsSetSingleValues**						
Continuous Operation Support **SupportsContinuous**	Yes				Yes	
Continuous Operation until Trigger **SupportsContinuousPreTrigger**						
Continuous Operation before & after Trigger **SupportsContinuousPrePostTrigger**						
Waveform Operations Using FIFO Only **SupportsWaveformModeOnly**						
Simultaneous Start List Support **SupportsSimultaneousStart**						
Interrupt Support **SupportsInterruptOnChange**						
Output FIFO Size **FifoSize**						

Buffering

Table 7: DT9816 Buffering Options

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Buffer Support **SupportsBuffering**	Yes					
Single Buffer Wrap Mode Support **SupportsWrapSingle**						
Inprocess Buffer Flush Support **SupportsInProcessFlush**	Yes					

Triggered Scan Mode

Table 8: DT9816 Triggered Scan Mode Options

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Triggered Scan Support **SupportsTriggeredScan**						
Maximum Number of CGL Scans per Trigger **MaxMultiScanCount**	0		0	0	0	
Maximum Retrigger Frequency **MaxRetriggerFreq**	0		0	0	0	
Minimum Retrigger Frequency **MinRetriggerFreq**	0		0	0	0	

Data Encoding

Table 9: DT9816 Data Encoding Options

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Binary Encoding Support **SupportsBinaryEncoding**	Yes		Yes	Yes	Yes	
Twos Complement Support **SupportsTwosCompEncoding**						

Channels

Table 10: DT9816 Channel Options

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Number of Channels **NumberOfChannels**	6[a]		1	1	1	
SE Support **SupportsSingleEnded**	Yes					
SE Channels **MaxSingleEndedChannels**	6		0	0	0	
DI Support **SupportsDifferential**			Yes	Yes	Yes	
DI Channels **MaxDifferentialChannels**	0		1	1	1	
Maximum Channel-Gain List Depth **CGLDepth**	6[b]		0	0	0	
Simultaneous Sample-and-Hold Support **SupportsSimultaneousSampleHold**	Yes					
Channel-List Inhibit **SupportsChannelListInhibit**						

a. The DT9816 provides analog input channels 0 to 5.

b. You cannot specify the same channel more than once in the list. Place channels in your channel list in ascending order. All channels are sampled simultaneously with data returned in ascending channel order; if your channel does not match, you will have unexpected results.

Gain

Table 11: DT9816 Gain Options

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Programmable Gain Support **SupportsProgrammableGain**	Yes					
Number of Gains **NumberOfSupportedGains**	2		1	1	0	
Gains Available **SupportedGains**	1, 2		1	1		

Ranges

Table 12: DT9816 Range Options

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Number of Voltage Ranges **NumberOfRanges**	1		0	0	0	
Available Ranges **SupportedVoltageRanges**	±10 V					
Current Output Support **SupportsCurrentOutput**						

Resolution

Table 13: DT9816 Resolution Options

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Programmable Resolution **SupportsSoftwareResolution**						
Number of Resolutions **NumberOfResolutions**	1		1	1	1	
Available Resolutions **SupportedResolutions**	16		8	8	16	

Thermocouple Support

Table 14: DT9816 Thermocouple Support Options

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Thermocouple Support **SupportsThermocouple**						
Voltage Converted to Temperature in Hardware **SupportsTemperatureDataInStream**						
Supported Thermocouple Types **ThermocoupleType**						
Returns Floating-Point Values **ReturnsFloats**						
Supports CJC Source Internally in Hardware **SupportsCjcSourceInternal**						
Supports CJC Channel **SupportsCjcSourceChannel**						

Table 14: DT9816 Thermocouple Support Options (cont.)

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Available CJC Channels **CjcChannel**						
Supports Interleaved CJC Values in Data Stream **SupportsInterleavedCjc TemperaturesInStream**						

IEPE Support

Table 15: DT9816 IEPE Support Options

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Programmable AC Coupling **SupportsACCoupling**						
Software Programmable DC Coupling **SupportsDCCoupling**						
Software Programmable External Excitation Current Source **SupportsExternalExcitationCurrent Src**						
Software Programmable Internal Excitation Current Source **SupportsInternalExcitationCurrentSrc**						
Available Excitation Current Source Values **SupportedExcitationCurrentValues**						

Triggers

Table 16: DT9816 Trigger Options

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Trigger Support **SupportsSoftwareTrigger**	Yes				Yes	
External Positive TTL Trigger Support **SupportsPosExternalTTLTrigger**					Yes	
External Negative TTL Trigger Support **SupportsNegExternalTTLTrigger**	Yes					
External Positive TTL Trigger Support for Single-Value Operations **SupportsSvPosExternalTTLTrigger**						
External Negative TTL Trigger Support for Single-Value Operations **SupportsSvNegExternalTTLTrigger**						
Positive Threshold Trigger Support **SupportsPosThresholdTrigger**						
Negative Threshold Trigger Support **SupportsNegThresholdTrigger**						
Digital Event Trigger Support **SupportsDigitalEventTrigger**						

Clocks

Table 17: DT9816 Clock Options

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Internal Clock Support **SupportsInternalClock**	Yes				Yes	
External Clock Support **SupportsExternalClock**	Yes				Yes	
Simultaneous Input/Output on a Single Clock Signal **SupportsSimultaneousClocking**	Yes					
Base Clock Frequency **BaseClockFrequency**	0		0	0	0	
Maximum Clock Divider **MaxExtClockDivider**	48 MHz		0	0	12 MHz	
Minimum Clock Divider **MinExtClockDivider**	2		1	1	65534[a]	
Maximum Frequency **MaxFrequency**	1		1	1	2	
Minimum Frequency **MinFrequency**	150 kHz[b]		0	0	6 MHz	

a. The module supports only even number values for the clock divider. Odd values are rounded down.

b. Actual maximum is 153.846 kHz.

Counter/Timers

Table 18: DT9816 Counter/Timer Options

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
Cascading Support **SupportsCascading**						
Event Count Mode Support **SupportsCount**					Yes	
Generate Rate Mode Support **SupportsRateGenerate**					Yes	
One-Shot Mode Support **SupportsOneShot**						
Repetitive One-Shot Mode Support **SupportsOneShotRepeat**						
Up/Down Counting Mode Support **SupportsUpDown**						
Edge-to-Edge Measurement Mode Support **SupportsMeasure**						
Continuous Edge-to-Edge Measurement Mode Support **SupportsContinuousMeasure**						
High to Low Output Pulse Support **SupportsHighToLowPulse**					Yes	
Low to High Output Pulse Support **SupportsLowToHighPulse**						
Variable Pulse Width Support **SupportsVariablePulseWidth**					No[a]	
None (internal) Gate Type Support **SupportsGateNone**					Yes	
High Level Gate Type Support **SupportsGateHighLevel**					Yes	
Low Level Gate Type Support **SupportsGateLowLevel**						

Table 18: DT9816 Counter/Timer Options (cont.)

DT9816	A/D	D/A	DIN	DOUT	C/T	QUAD
High Edge Gate Type Support **SupportsGateHighEdge**						
Low Edge Gate Type Support **SupportsGateLowEdge**						
Level Change Gate Type Support **SupportsGateLevel**						
Clock-Falling Edge Type **SupportsClockFalling**						
Clock-Rising Edge Type **SupportsClockRising**						
Gate-Falling Edge Type **SupportsGateFalling**						
Gate-Rising Edge Type **SupportsGateRising**						
Interrupt-Driven Operations **SupportsInterrupt**					Yes	

a. The pulse width (duty cycle) if fixed at 50% when rate generation mode is used.

8

Troubleshooting

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General Checklist

Should you experience problems using a DT9816 module, do the following:

1. Read all the documentation provided for your product. Make sure that you have added any "Read This First" information to your manual and that you have used this information.
2. Check the OMNI CD for any README files and ensure that you have used the latest installation and configuration information available.
3. Check that your system meets the requirements stated in Chapter 2.
4. Check that you have installed your hardware properly using the instructions in Chapter 3.
5. Check that you have installed and configured the device driver properly using the instructions in Chapter 3.
6. Check that you have wired your signals properly using the instructions in Chapter 4.
7. Search the DT Knowledgebase in the Support section of the Data Translation web site (at www.datatranslation.com) for an answer to your problem.
8. Visit the product's page on the Data Translation web site for the latest tips, white papers, product documentation, and software fixes.

If you still experience problems, try using the information in Table 19 to isolate and solve the problem. If you cannot identify the problem, refer to page 87.

Table 19: Troubleshooting Problems

Symptom	Possible Cause	Possible Solution
Module is not recognized	You plugged the module into your computer before installing the device driver.	From the Control Panel > System > Hardware > Device Manager, uninstall any unknown devices (showing a yellow question mark). Then, run the setup program on your OMNI CD to install the USB device drivers, and reconnect your USB module to the computer.
Module does not respond.	The module configuration is incorrect.	Check the configuration of your device driver; see the instructions in Chapter 3.
	The module is damaged.	Contact Data Translation for technical support; refer to page 90.
Intermittent operation.	Loose connections or vibrations exist.	Check your wiring and tighten any loose connections or cushion vibration sources; see the instructions in Chapter 4.
	The module is overheating.	Check environmental and ambient temperature; consult the module's specifications on page 98 of this manual and the documentation provided by your computer manufacturer for more information.
	Electrical noise exists.	Check your wiring and either provide better shielding or reroute unshielded wiring; see the instructions in Chapter 4.

Table 19: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
Device failure error reported.	The module cannot communicate with the Microsoft bus driver or a problem with the bus driver exists.	Check your cabling and wiring and tighten any loose connections; see the instructions in Chapter 4.
	The module was removed while an operation was being performed.	Ensure that your module is properly connected; see the instructions in Chapter 3.
Data appears to be invalid.	An open connection exists.	Check your wiring and fix any open connections; see the instructions in Chapter 4.
	A transducer is not connected to the channel being read.	Check the transducer connections; see the instructions in Chapter 4.
	The transducer is set up for differential inputs.	Check your wiring and ensure that your transducer is set up for single-ended inputs; see the instructions in Chapter 4.
	The DT9816 module is out of calibration.	The DT9816 module is calibrated at the factory and should not require recalibration. If you want to readjust the calibration of the analog input or analog output circuitry, refer to the instructions on the Data Translation web site (www.datatranslation.com).

Table 19: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
Computer does not boot.	The power supply of the computer is too small to handle all the system resources.	Check the power requirements of your system resources and, if needed, get a larger power supply; consult the module's specifications on page 98 of this manual.
USB 2.0 is not recognized.	Your operating system does not have the appropriate Service Pack installed.	Ensure that you load the appropriate Windows Service Pack (version 2 for Windows XP or version 4 for Windows 2000). If you are unsure of whether you are using USB 2.0 or USB 1.1, run the Open Layers Control Panel applet, described in Chapter 3.
	Standby mode is enabled on your PC.	For some PCs, you may need to disable standby mode on your system for proper USB 2.0 operation. Consult Microsoft for more information.

Technical Support

If you have difficulty using a DT9816 module, Data Translation's Technical Support Department is available to provide technical assistance.

To request technical support, go to our web site at http://www.datatranslation.com and click on the Support link.

When requesting technical support, be prepared to provide the following information:

- Your product serial number
- The hardware/software product you need help on
- The version of the OMNI CD you are using
- Your contract number, if applicable

If you are located outside the USA, contact your local distributor; see our web site (www.datatranslation.com) for the name and telephone number of your nearest distributor.

If Your Module Needs Factory Service

If your module must be returned to Data Translation, do the following:

1. Record the module's serial number, then contact the Customer Service Department at (508) 481-3700, ext. 1323 (if you are in the USA) and obtain a Return Material Authorization (RMA).

   If you are located outside the USA, call your local distributor for authorization and shipping instructions. The name and telephone number of your nearest distributor are listed on Data Translation's web site. All return shipments to Data Translation must be marked with the correct RMA number to ensure proper processing.

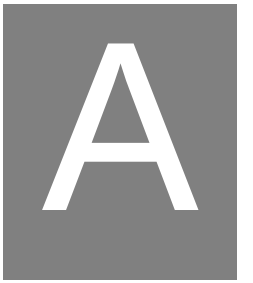
2. Using the original packing materials, if available, package the module as follows:

   – Wrap the module in an electrically conductive plastic material. Handle with ground protection. A static discharge can destroy components on the module.

   – Place in a secure shipping container.

3. Return the module to the following address, making sure the RMA number is visible on the outside of the box.

   Customer Service Dept.
   Data Translation, Inc.
   100 Locke Drive
   Marlboro, MA 01752-1192



Specifications

Table 20 lists the specifications for the A / D subsystem on the DT9816 module.

Table 20: A/D Subsystem Specifications

Feature	DT9816 Specifications
Number of analog input channels	6 single-ended
Number of gains	2 (1, 2)
Resolution	16-bit
Data encoding	offset binary
System accuracy, to % of FSR (Averaged over 50 readings)	 ±0.08%
Range	±5 V, ±10 V
Nonlinearity	0.015%
Differential nonlinearity	0.003%
Inherent quantizing error	±½ LSB
Drift Zero: Gain:	 ±25 µV/°C ±50 ppm/°C
Differential linearity:	monotonic to 14 bits
Input impedance[a] Off channel: On channel:	 — 10 MΩ, 10 pf
Input bias current	±10 nA
Maximum input voltage (without damage) Power on: Power off:	 ±35 V ±20 V

Table 20: A/D Subsystem Specifications (cont.)

Feature	DT9816 Specifications
A/D conversion time	4 µs (DT9816-A) 8 µs (DT9816)
Channel acquisition time (±½ LSB)	1 µs
Sample-and-hold Aperture uncertainty: Aperture delay: Aperture match: Gain match: Zero match:	 1 ns 35 ns 5 ns 0.05% ±3.0 mV
Throughput	50 kHz per channel (DT9816) 150 kHz per channel (DT9816-A)
ESD protection (per spec) Arc: Contact:	 8 kV 4 kV
Reference	2.5 V
Monotonicity	Yes

a. Very high input impedance minimizes any source error.

Table 21 lists the specifications for the digital input (DIN) and digital output (DOUT) subsystems on the DT9816 module.

Table 21: DIN/DOUT Subsystem Specifications

Feature	DT9816 Specifications
Number of digital I/O lines	16 (8 each; dedicated)
Number of ports	2, 8-bit
Input termination	Series 1 kΩ; Series 33.2 Ω
Logic family	TTL
Logic sense	Positive true
Inputs Input type: Input logic load: High input voltage: Low input voltage: Low input current:	 Level sensitive 1 TTL Load 2.4 V min 0.8 V max -0.4 mA max
Outputs High output: Low output: High output current (source): Low output current (sink):	 2.8 V min 0.6 V max 4.5 mA 10 mA
Software I/O selectable	Yes
ESD protection (per spec) Arc: Contact:	 8 kV 4 kV

A

Table 22 lists the specifications for the C/T subsystem on the DT9816 module.

Table 22: C/T Subsystem Specifications

Feature	Specifications
Number of counter/timers	1
Counter/timer modes	Event counting, frequency measurement, rate generation
Resolution	16-bit
Minimum pulse width: (minimum amount of time it takes a C/T to recognize an input pulse)	25 ns
Logic family	TTL
Inputs Input logic load: High input voltage: Low input voltage: Low input current:	Level sensitive 1 TTL Load 2.4 V min 0.8 V max -0.4 mA max
Outputs High output: Low output: High output current (source): Low output current (sink):	 2.8 V min 0.6 V max 2 mA 12 mA
ESD protection (per spec) Arc: Contact:	 8 kV 4 kV
Internal clock frequency	60 Hz to 6 MHz
External clock divider	2 to 65534

Table 23 lists the power, physical, and environmental specifications for the DT9816 module.

Table 23: Power, Physical, and Environmental Specifications

Feature	DT9816 Specifications
Power, +5 V Enumeration Operation	<100 mA <250 mA
Physical Dimensions (board): Dimensions (box with screw terminals and feet): Weight (board): Weight (box with screw terminals and feet):	 100 mm (L) x 100 mm (W) x 15.5 mm (H) 107.7 mm (L) x 100 mm (W) x 33.5 mm (H) 65.8 g 138.8 g
Environmental Operating temperature range: Storage temperature range: Relative humidity:	 0 to 55° C -40 to 85° C to 95% non-condensing

B

Screw Terminal Assignments

Table 24 lists the screw terminal assignments for the DT9816 module.

Table 24: DT9816 Screw Terminal Assignments

Screw Terminal	Signal	Screw Terminal	Signal
20	USB +5 V Out	40	Ext Trigger
19	Ground	39	Ext Clock
18	Counter 0 In	38	Ground
17	Counter 0 Out	37	Digital Output 7
16	Counter 0 Gate	36	Digital Output 6
15	Ground	35	Digital Output 5
14	Reserved	34	Digital Output 4
13	Reserved	33	Digital Output 3
12	Reserved	32	Digital Output 2
11	Reserved	31	Digital Output 1
10	2.5 V Reference	30	Digital Output 0
9	Analog Ground	29	Ground
8	Reserved	28	Digital Input 7
7	Reserved	27	Digital Input 6
6	Analog Input CH5	26	Digital Input 5
5	Analog Input CH4	25	Digital Input 4
4	Analog Input CH3	24	Digital Input 3
3	Analog Input CH2	23	Digital Input 2
2	Analog Input CH1	22	Digital Input 1
1	Analog Input CH0	21	Digital Input 0

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